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ABSTRACT

The purpose of this study was to investigate the roles parents play in students' learning of mathematics in the home setting and to examine the relationships between parental involvement and students' learning of mathematics. This study attempts to identify the kinds of parental roles which contribute to students' learning of mathematics. This study also attempts to provide empirical evidence of the relationship of parental involvement to students' mathematical achievement and attitude toward mathematics. Approximately 60% of the primary guardians of 220 middle school students returned a completed Parental Involvement Questionnaire (PIQ) which was designed to assess the parents' level of support in five roles as: (1) motivator; (2) resource provider; (3) monitor; (4) content adviser; and (5) learning counselor. Students with the most supportive parents demonstrated higher mathematics achievement and more positive attitudes towards mathematics than those students with the least supportive parents. Also, students whose parents did not return the PIQ demonstrated lower mathematics achievement and less positive attitudes towards mathematics than those students whose parents returned the PIQ. The measures relating to the roles of parents as motivators, resource providers, and monitors were found to be the most important in predicting students' mathematics achievement. (AIM)

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Parental Roles in Students' Learning of Mathematics

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Running Head: PARENTAL ROLES

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Parental Roles in Students' Learning of Mathematics: An Exploratory Study

ABSTRACT

Approximately 60% of the primary guardians of 220 middle school students returned a completed Parental Involvement Questionnaire (PIQ), which was designed to assess the parents' level of support in five roles: as motivator, resource provider, monitor, content adviser, and learning counselor. Students with the most supportive parents demonstrated higher mathematics achievement and more positive attitudes towards mathematics than students with the least supportive parents. Moreover, students whose parents did not return the PIQ demonstrated lower mathematics achievement and less positive attitudes towards mathematics than students whose parents returned the PIQ. The measures relating to the roles of parents as motivator, resource provider, and monitor were found to be the most important in predicting students' mathematics achievement, in contrast to the roles of parents as content adviser and learning counselor.

INTRODUCTION

A strong relationship between home background variables and student performance is well-documented (Robitaille & Garden, 1989; Wang, Haertel, & Walberg, 1993). One such variable is related to the parental involvement in students' education. Researchers have known that the involvement of parents contributes to not only their children's higher academic achievement, but also their positive behaviors and emotional development (Henderson, 1987; Jacobs, 1992; Weston, 1989). Cross-national studies in mathematics suggest that parental encouragement and realistic expectations are related to children's school work (e.g., Robitaille & Garden, 1989; Stevenson & Lee, 1990). Although the importance of parental involvement in students' education does not seem to be debatable, the kind of parental roles that are most effective is still an open question. Previous research in parental involvement focused mainly on general kinds of involvement aimed at strengthening overall school program (e.g., advisory, fundraising, and advocacy activities) and assisting one's own child (e.g., helping with homework). Less research has been done to examine specific kinds of parental involvement aimed at facilitating students' learning of mathematics in home settings.

The purpose of this study was to investigate the roles parents play in students' learning of mathematics in the home setting and to examine the relationships between parental involvement and students' learning of mathematics. In particular, this study attempted to identify the kinds of parental roles which contribute to students' learning of mathematics. This study also attempted to provide empirical evidence about the relatedness of parental involvement to students' mathematical achievement and attitude toward mathematics.

PARENTAL ROLES IN STUDENTS' LEARNING

Recognition of the importance of parental involvement in students' education is not new (Berger, 1991). In 1897, Hauschmann indicated that "[a]ll are looking for reform in education....If [the] building is not to be solid, we must look to the foundations--the home" (Quoted in White, Taylor, & Moss, 1992, p. 91). The role of parents in their children's education has been continuously recognized to the present time. Many

researchers have attempted to investigate the amount and type of parental involvement in students' education. For example, Eccles and Harol (1993) have identified five variables to examine parental involvement with teachers and at school: Monitor (parent response to teacher request and information), volunteer (the rate of parent participation in volunteer activities at school), involvement (parent report of frequency of involvement with child's daily activities), progress (Do you contact the school about child's progress?), and extra help (Do you contact the school about how to give extra help?). In contrast, Haynes and Ben-Avie (1996) examined a three-tier model of parental involvement: (3) general participation, (2) helping in classrooms or sponsoring and supporting school programs, and (1) parent participation on the school planning and management team.

Although researchers appeared to propose different types of parental involvement in students' education, they can be summarized into the following two kinds of general parental involvement: (1) participation in a range of school activities aimed at strengthening the overall school program, and (2) assistance of one's own child at home in informal and in school directed learning tasks (Greenwood & Hickman, 1991). Researchers have mainly focused on the discussion of improving parent-school collaboration. Parental roles with respect to their support of students' learning in home settings have been less examined (Ascher, 1988). Furthermore, most studies of parental involvement were done with elementary school students. Less research has been done to examine parental involvement in middle and secondary school students' learning. For those studies involving both elementary and middle and/or secondary school students, researchers found that parental involvement at school declined dramatically as students moved from elementary school to middle school or secondary school (Eccles & Harold, 1993; Epstein, 1986). Recently, some researchers suggested parents should also be involved with their children's education at home, even in middle school (e.g., Eccles & Harold, 1993). There is a need to study parental involvement which assists middle school students' learning in home settings.

There are two important dimensions which should be considered in examining parental roles in assisting students' learning in home settings. The first is the roles

parents play in directly assisting students' learning (e.g., home tutoring). The second is the roles parents play in providing emotional and resource support in students' learning. Traditionally, researchers focused on the examination of the first type of parental roles. However, some researchers (e.g., Nieto, 1992) have indicated that traditional family support (e.g., checking homework) does not seem to be as effective as expected. Cross-national studies in mathematics seem to suggest that parental emotional support is related to students' success in mathematics. This study examines both types of parental roles in students' learning of mathematics.

In particular, this study examines five parental roles of two different types: Parents as Motivator, Parents as Resource Provider, Parents as Monitor, Parents as Mathematics Content Adviser, and Parents as Mathematics Learning Counselor. Parents as mathematics content adviser and mathematics learning counselor are roles of the type that parents play in directly assisting students' learning of mathematics in the home setting. Parents as motivator, resource provider, and monitor are roles of the type that parents play in providing emotional and resource support in students' learning. These five parental roles were identified based on systematic reviews of literature on parental involvement (e.g., Booth & Dunn, 1996; Hoover-Dempsey & Sandler, 1995; Sigel, McGillicuddy-Delisi, 1992; White, Taylor, & Moss, 1992), educational policy (e.g., Sarason, 1995), mathematics education reform (e.g., Merttens & Vass, 1993; NCTM, 1989), and cross-national studies (Stevenson & Lee, 1990).

METHOD

Subjects.

The subjects consisted of 220 sixth-, seventh-, and eighth-grade students from a public school in a large urban school district and their primary guardians. The students are ethnically and culturally diverse, with 84% of them qualifying for free or reduced lunch. Fifty-seven percent (57%) are African American, 20% are Hispanic, 15% are white, and 8% are "other."

Measure of Parental Involvement.

A Parental Involvement Questionnaire (PIQ) was developed to assess parental involvement in students' learning of mathematics (Cai, Moyer, & Wang, 1996). The PIQ was designed to assess parental roles as motivators (parents provide emotional support to students' learning); resource providers (parents play the role of resource provider at home by providing an appropriate place to study, by buying relevant reference books, and/or accessing library); monitors (parents monitor their children's learning and progress at home); content advisers (parents provide advice to their children on mathematics content); and, learning counselors (parents understand their children's current situation, learning difficulties, potential, needs, and demands, and provide appropriate support to help their children to overcome learning difficulties). A group, consisting of university mathematics education professors, middle school mathematics teachers, and parents was asked to evaluate each of the items in the PIQ with respect to the relevance, clarity, ratability, and completeness. Revisions were made based on their evaluations. The PIQ consists of 26 items, which are statements with positive or negative valences. Six items were selected and modified from the National Assessment of Educational Progress' student attitude inventory to examine parents' perceptions about the nature of mathematics. These six items and the 26 PIQ items were combined together as a booklet. Each student was asked to take the instrument home, and have one of their parents or guardians complete it. For each of the items, the parents were asked to decide whether they "strongly agree", "agree", "disagree", or "strongly disagree". To "force" tendency selection, no neutral choice was provided.

For each of the statements with positive valences, if a parent or guardian chose "strongly agree", the response was scored as 4 for the item. If a parent chose "agree", the response was scored as 3. If a parent chose "disagree", the response was scored as 2. If a parent chose "strongly disagree", the response was scored as 1. However, for each of the statements with negative valences, if a parent chose "strongly agree", the response was scored as 1 for the item. If a parent chose "agree", the response was scored as 2. If a parent chose "disagree", the response was scored as 3. If a parent chose "strongly

disagree", the response was scored as 4. A study by Authors (1996) has shown that the PIQ appears to be a reliable and valid instrument for assessing parental involvement in students' learning of mathematics. The Cronbach's coefficient alpha for the PIQ is .86. The return rate for the PIQ was 58.6%.

Measures of Students' Mathematical Achievement

Students' mathematical achievement was measured using a mathematical proficiency test developed and administered by the school district and a performance-based assessment developed by the researchers. The proficiency test consisted of six open-ended, short-answer tasks assessing mathematical knowledge and skills and two extended open-ended problems assessing mathematical thinking and problem-solving skills. The performance-based assessment consisted of seven extended open-ended tasks, which were designed to measure students' number sense, symbol sense, function sense, proportional reasoning, and contextualized equation solving.

Each response to the short-answer tasks in the mathematical proficiency test was scored using a three-point scale (0-2). Each response to the two extended open-ended problems in the mathematical proficiency test was scored using a six-point scale (1-6). Scoring of the mathematical proficiency test was completed by a group of middle school mathematics teachers in the school district. Each response to the seven extended open-ended problems in the mathematical performance assessment was scored by the researchers using a 5-point scale (0-4).

Measures of Students' Attitude toward Mathematics

A subset of 14 attitude items from the National Assessment of Educational Progress' student attitude inventory was adapted to measure students' attitudes toward mathematics.

RESULTS

Results of the PIQ

Appendix A shows the item analysis of the items from the PIQ booklet. For the purpose of readability, the PIQ items are grouped into six categories according to parental

roles and perception of mathematics. However, the items were mixed in the PIQ booklet when it was administered to parents. The following is a summary of the PIQ results.

Parent as motivator. Most of the parents who completed the PIQ seem to consistently provide emotional support for students' learning of mathematics. For example, 90% of the parents responded that at home they encourage their children to work hard on mathematical problems even though the problems are hard. Over 90% of the parents felt that math plays important roles in their children's future lives and about 70% of them expressed that they usually try to motivate their childen to do well on mathematics. However, about one-third of the parents expressed that they do not know how to motivate their children to do well on mathematics.

Parents as resource provider. Over 90% of the parents felt that they tried hard to have a nice learning environment at home for their children to do mathematics. About two-thirds of the parents often take their children to public libraries, but only one-third buy math-related books. Nearly 60% of the parents expressed that their households have a variety of games and puzzles that encourage the development of children's math skills.

Parents as monitor. Although over 80% of the parents responded that they check their children's homework regularly, about 40% of them said they seldom spend time talking with their children about progress in math. Over 60% of the parents require their children to show the results on math homework. Only half of the parents know their children's mathematics requirements in school. About 40% of the parents did not even monitor the amount of the time their children spent on math at home.

Parents as mathematics content adviser. About 90% of the parents make an effort to understand the mathematics their children are studying at school, but less than half of the parents felt they know enough mathematics to help their children. Over 70% of the parents regularly discuss with their children how mathematics is used in daily life and help their children do mathematics homework.

Parents as mathematics learning counselor. Although 70% of the parents felt they know their children's strength and weakness in learning mathematics, 40% of them expressed that they do not know the strategies for helping their children overcome those

weaknesses. Over 70% of the parents try to figure out good approaches for helping their children learning math. With respect to the learning progress, about three quarters of the parents said that they try to match their expectations with their children's potential. Interestingly, over 60% of the parents are not aware of the approaches used to teach mathematics at schools.

Parents' perceptions of mathematics. As was indicated before, six items were selected and used to examine parents' perceptions about the nature of mathematics. The results suggested that nearly 60% of the parents felt learning mathematics is mostly memorizing. Although over 80% of them disagree that exploring patterns plays no part in learning mathematics, approximately 40% of them said that math uses symbols rather than ideas and understanding. About 90% of the parents expressed that knowing why an answer is correct is as important as getting the answer and math problems can be solved in different ways, but over 80% of them felt there is always a rule to follow in solving a mathematics problem. The results suggest that parents' perception of the nature of mathematics is incomplete and unclear.

Parental Involvement and Students' Mathematical Achievement and Attitudes

The PIQ score is moderately correlated with students' attitudes toward mathematics ($r = .24$, $p < .01$), mathematical proficiency test score ($r = .22$, $p < .01$), and mathematical performance assessment score ($r = .25$, $p < .01$). Using the PIQ total score, the most supportive and least supportive parents were differentiated. The most supportive parents consist of those parents whose scores are in the top 30% and the least supportive parents consist of those parents whose scores are in the bottom 30%. The mean PIQ score for the most supportive parents is 85, which is significantly higher than that for the least supportive parents, 63 ($t = 17.26$, $p < .001$).

Next students' attitudes and achievement with the most and least supportive parents were examined. Table 1 shows the students' mean scores on the student attitude items, mathematical proficiency test, and performance assessment. Students with the most supportive parents demonstrated higher achievement measured by the mathematical proficiency test ($t = 2.38$, $p < .05$) and by the performance-based assessment ($t = 3.02$, $p <$

.01) than those students with the least supportive parents. Students with the most supportive parents also demonstrated more positive attitudes toward mathematics than those students with the least supportive parents ($t = 2.16$, $p < .05$).

Insert Table 1 about here

As was indicated above, the return rate for the PIQ was 58.6%. There are undoubtedly many reasons why some of the parents did not complete their PIQ. Whatever the reason, their failure to complete it might be an indication of their reluctance to become involved in their children's learning. To have a further understanding of the relatedness of parental involvement and students' attitude and achievement, students' scores on the measures of attitudes and achievement for those whose parents completed the PIQ and those whose parents did not complete the PIQ were examined and compared. Table 2 shows the mean scores of students whose parents completed the PIQ and those whose parents did not complete the PIQ. As is shown in Table 2, students whose parents completed the PIQ performed better on the mathematical proficiency test ($t = 3.59$, $p <$ .01) than those students whose parents did not complete the PIQ. Students whose parents completed the PIQ also showed more positive attitudes toward mathematics than those students whose parents did not complete the PIQ ($t = 2.01$, $p < .05$). Students whose parents completed the PIQ had a higher mean score on the performance-based mathematics assessment than those students whose parents did not complete the PIQ, although the difference is not statistically significant ($t = 1.71$, $p = .09$).

Insert Table 2 about here

Parental Roles in Students' Learning of Mathematics

Regression analyses were conducted to examine how each of the parental roles (Motivator, Resource Provider, Monitor, Mathematics Content Adviser, and Mathematics Learning Counselor) contributes to students' academic success. The results of the

regression analyses suggest that all five parental roles as a whole significantly contribute to predict students' mathematical achievement measured by both the mathematical proficiency test ($p < .005$) and the performance-based assessment ($p < .05$). Stepwise regression analyses were also conducted. The results consistently suggest that the independent variables related to parents as motivators, resource providers, and monitors are the most important predictors for students' mathematical achievement. Further, the results suggest that independent variables related to parents as content advisers and learning counselors can be removed from the regression model.

The coefficient of determination (R^2) for the regression analysis using five parental roles as independent variables and mathematical proficiency test as dependent variable is .145. This means that about 15% of the variability of students' achievement measured by the mathematical proficiency test is accounted for the variability of parental involvement measured by the PIQ. Similarly, the value of R^2 for the regression analysis using five parental roles as independent variables and mathematical performance assessment as dependent variable is .131. This means that about 13% of the variability of students' achievement measured by the mathematical performance assessment is accounted for the variability of parental involvement measured by the PIQ. If the independent variables related to parents as content advisers and learning counselors are removed from the regression models, the values of R^2 are reduced to .138 when the proficiency test is the dependent variable and .127 when the performance assessment is the dependent variable.

DISCUSSION

The PIQ was developed to assess parental involvement in their children's learning of mathematics. An earlier study suggests that the PIQ may be a reliable and valid instrument for assessing parental involvement in students' learning of mathematics (Authors, 1996). Using the PIQ instrument, this study explored parental involvement from five aspects: parents as motivators, resource providers, monitors, mathematics content adviser, and mathematics learning counselor. This study also examined the

relationships between parental involvement and students' mathematical achievement and attitude.

It has been demonstrated elsewhere that parent attitudes toward the child as a learner of mathematics was a significant predictor of mathematics achievement (Pedersen, Elmore, & Bleyer, 1986). The results of this study suggest that parental involvement is also a significant predictor of students' mathematical achievement. All five parental roles together significantly contribute to the prediction of students' achievement. Of the five parental roles, however, parents as motivators, resource providers, and monitors seem to be the most important predictors for students' mathematical proficiency levels. Parents as content advisers and learning counselors are less important predictors. This finding is consistent with the findings from some of the cross-national studies, on which Asian students generally outperformed U.S. students. For example, Stevenson and Lee (1990) found that American parents were more likely to actually help their children with homework than to ask them about their mathematics classes. In contrast, Asian parents were more likely to ask their children about their mathematics classes than to actually help them with their homework. Asian parents (especially mothers) have less formal education than American parents. Therefore, Asian parents may be less able to act as mathematics content advisers and learning counselors than American parents. However, Asian parents consistently motivate their children to achieve academic success and monitor their learning at home. Asian parents' realistic expectations and consistent encouragement may significantly contribute to Asian students' success in mathematics.

The finding that parents as motivators, resource providers, and monitors are the most important predictors of students' mathematical achievement has practical implications. Parents are such strong role models that their actions often have a stronger influence than their words on their children's value system. The parental role of motivator is a difficult one for many American parents because they themselves often harbor negative feelings stemming from their own mathematical failings. If parents believe that most children have trouble with mathematics, they often feel justified in

lowering their expectations for their own children. Parents find it especially difficult to motivate their children to learn mathematics well if they themselves do not value mathematics. Even if parents concur with the abstract notion that mathematics is an important subject, their own practical experience often tells them otherwise: they were able to find successful employment with only minimal mathematics skills, and they use very little school mathematics beyond arithmetic in their daily living. To be an effective motivator, parents must truly believe that it is not only important for their children to be successful at mathematics, but also that their children can be successful if they work hard on math problems even though the problems are difficult.

The role of resource provider can easily be overlooked by parents, or its importance downplayed. It is human nature to expend energy and provide resources to obtain outcomes that are valued. However, it is not enough to value outcomes, it is also important to know what resources are needed. The effective parental resource provider is aware that tools and environment play critical roles in the child's attainment of mathematical expertise, and will understand that mathematics learning can suffer unless significant energy is expended providing them. Important home resources include a quiet place to study, tools such as calculators and rulers, games and puzzles, math-related books, and encouragement to use outside resources such as a public library.

Although most children do not realize it, they crave structure in their lives. It is important for parents to help their children choose an appropriate place and time to do homework each day, and also to allocate an appropriate amount of time to spend on mathematics in relation to their other subjects. Once a home learning structure is agreed upon, parents should be on hand to monitor their children's perseverance. They need to regularly assess their children's progress in mathematics by discussing their math assignments and notebooks, as well as the results of tests and quizzes. In this way they can negotiate changes in the home learning structure, if the child's progress requires it.

Given the current mathematics education reform with an emphasis on reasoning, problem-solving, conceptual understanding, and communicating mathematically, school mathematics has changed from the time when parents were in schools. Some new

mathematics topics such as discrete mathematics, estimation, applications of calculators and computers have been recently integrated into the school curriculum. As a result, parents might be less able to act as mathematics content advisers and learning counselors at home. Many parents may be intimidated by the thought of helping their children do mathematics homework. Even if they feel confident using mathematics in their everyday life, they often do not understand the mathematics content their children are learning. As their children get older, and the mathematics becomes more complicated, many parents no longer make the effort to understand the mathematics their children are studying. As a result, they shy away from helping their children with their mathematics homework. In fact, only about one-third of the parents surveyed in this study felt they knew enough mathematics to help their children at home. A majority of the parents felt learning mathematics is mostly memorizing and they do not know strategies for helping students learn mathematics. Unfortunately, their feelings of inadequacy in the role of mathematics content adviser can adversely affect their willingness to engage in the other parental roles, which may be of even greater effectiveness in promoting their children's success in mathematics. For parents to be successful in their roles as mathematics learning counselor, they must have special insight into their children's strengths and weaknesses in learning mathematics. They also need to understand the approaches used to teach mathematics at their children's schools and to encourage their children to use strategies that capitalize on their children's strengths and are consistent with the schools' approaches. This role, like the role of mathematics content adviser, requires a specialized knowledge that can make it more difficult to be effective than in the other three roles. In that sense, parents are better able to act as motivators, resource providers, and monitors of students' mathematics learning at home. The teachers, on the other hand, should be expected to take primary responsibility as mathematics content advisers and learning counselors in school.

This study also examined the relationships between parent involvement and students' mathematical proficiency levels and attitudes. The results of this study revealed that the students with the most supportive parents not only have higher proficiency levels,

but also more positive attitudes toward mathematics than those students with the least supportive parents. Consistent with studies by other researchers (e.g., Johnson & Jason, 1994; Henderson, 1987), the findings in this study provide empirical evidence that parental involvement benefits students' learning of mathematics. That parental involvement benefits students' learning of mathematics is also evident by the fact that students whose parents completed the PIQ have significantly higher mathematical proficiency levels than those students whose parents did not complete the PIQ. Students whose parents completed the PIQ also showed more positive attitude toward mathematics than those students whose parents did not complete the PIQ.

Many parents believe that they should disengage from their children as they move into middle and high school because children in this age are seeking and need independance. The results of this study suggest that parents still play a significant role in middle school students' learning of mathematics. Parental involvement is still a siginificant predictor in middle school students' mathematical achievement. "Adolescents may indeed want greater autonomy, but they still need to know that their parents support their educational endeavors. They need a safe heaven in which to explore their independance" (Eccles & Harold, 1993, p. 575). However, it should be indicated that only about 15% of the variance in students' achievement measure can be explained by the variability of parental involvement measured by the PIQ. This implies that we should encourage parental involvement, but we should not overemphasize parental roles in students' learning of mathematics. As Hoover-Dempsey and Sandler (1995) indicated that parental involvement is neither a necessary nor a sufficient condition in itself for students' academic success in mathematics because parental involvement by itself does not enable students to acquire the full range of mathematical skills and knowledge necessary for success in school. Rather, parental involvement is an enhancing variable contributing to students' success in mathematics.

There is a current broad consensus that mathematics educators and teachers should promote practices that encourage parental involvement in students' learning of mathematics. Research shows that specific school and teacher practices are a major

factor influencing parental involvement (e.g., Epstein, 1986). Not only will the results of this study provide a basis for such practices, but also the framework of this study may actually facilitate such practices. Hopefully, the framework and instrument for assessing parental involvement in students' learning of mathematics presented in this paper will provide teachers and educators with guidelines to facilitate such practices.

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Table 1

Mean Scores on the Attitude Items, Proficiency Test, and Performance Assessment with the Most and Least supportive Parents

	Attitude	Proficiency Test	Performance Assessment
Students with the Most Supportive Parents	42.1	14.8	15.5
Students with the Least Supportive Parents	37.9	10.7	9.7

The maximun possible score for the attitude items is 56; the maxumun possible score for the mathematical proficiency test is 36; and the maximun possible score for the performance assessment is 28.

Table 2

Mean Scores on the Attitude Items, Proficiency Test, and Performance Assessment of Students with Parents Who Completed or Did not Completed the PIQ

	Attitude	Proficiency Test	Performance Assessment
Students with Parents Who Completed the PIQ	40.1	12.5	13.6
Students with Parents Who Did Not Complete the PIQ	36.8	8.9	9.4